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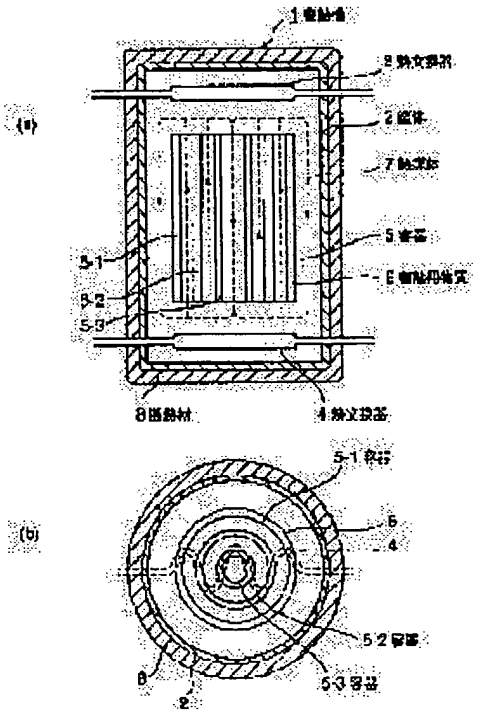
(54) HEAT STORAGE TANK



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a heat storage tank which is high in heat energy density with simple structure.

SOLUTION: Material 6 which can store a large quantity of heat in the form of heat of fusion by repeating the solidification and fusion within a range of objective temperature is put in lengthwise sealed containers 5, and a plurality of these containers 5 are put in heat media 7 for heat exchange in the form of not disturbing the convection movement of heat media 7 for heat exchange so as to form a heat storage tank 1.

CLAIMS

[Claim(s)]

[Claim 1]A heat exchanger which takes in heat, and a heat exchanger which takes out heat.

A heat carrier which moves heat.

A thermal storage material which carries out accumulation using the heat of fusion of a substance.

A case which accommodates them.

It is the heat storage tank provided with the above, and said substance for accumulation was put into a sealed longwise container, and as the longitudinal direction became towards a convection of a heat carrier, it has arranged two or more said containers.

[Claim 2]The heat storage tank according to claim 1 having arranged two or more said containers with which an outer wall and a wall are formed in a double pipe of the two same mind with few differences of a diameter, and seal the both ends, and said container is constituted, and also diameters differ to concentric circle shape.

[Claim 3]The heat storage tank according to claim 2 constituting the outside of a cylinder located in the outermost part among said two or more containers so that it may have heat insulation nature.

[Claim 4]The heat storage tank according to claim 1 or 2 having arranged a thermal shield pipe which has heat insulation nature between the outside of two or more of said containers, and a wall of said case so that these both may be separated.

[Claim 5]The heat storage tank according to claim 4, wherein said thermal shield pipe is a cylinder formed with a good material of heat insulation nature.

[Claim 6]The heat storage tank according to claim 1, wherein said container is the pipe which sealed both ends.

[Claim 7]The heat storage tank according to any one of claims 1 to 6, wherein said substance for accumulation is naphthalene.

[Claim 8]The heat storage tank according to any one of claims 1 to 7 forming a pump to which said heat carrier is moved towards a heat exchanger which takes out said heat towards a heat exchanger which takes out said heat near the heat exchanger which takes in said heat.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the heat storage tank which is used for the heat utilization system which has a time lag in supply and demand like the calorifier of night power use, or a solar water heater and in which thermal energy is stored.

[0002]

[Description of the Prior Art]The method of filling up the inside of the heat storage tank which put the substance which uses the large water of specific heat, makes hot water from the electric water heater for home use or solar water heater by night power, and conserves thermal energy conventionally, or causes the phase change between liquid phase-solid phase at a suitable temperature into the corpuscle-like container etc. and into which the heat carrier was put, etc. were taken. The former had the fault that the size of the heat storage tank to the energy which carries out accumulation was large, and the efficiency of the latter of the heat exchange of the substance and heat carrier which the free convection in a heat storage tank does not go smoothly, but cause a phase change was bad.

[0003]

[Problem(s) to be Solved by the Invention]With the heat storage tank used by a necessarily conflicting **** stem, the time which acquires energy like an electric water heater or a solar water heater, and the time using energy. Let it be a technical problem to provide the heat storage tank in which it is the same capacity as the heat storage tank which makes and carries out accumulation of the conventional hot hot water, and also many energies were stored.

[0004]

[Means for Solving the Problem]In order to solve the above-mentioned technical problem, this invention uses the heat of fusion of a substance. A lot of heat of fusion is needed for dissolving a substance, and when the substance solidifies, the heat of fusion is emitted so that it may be known well. A substance dissolved at a suitable temperature is put in in a heat storage tank into which this character was used for and heat carriers, such as water or an oil, went, and thermal energy is conserved in a form of the heat of fusion of this substance.

[0005]Therefore, structure which can be stored so that heat exchange between this

substance and heat carrier may be made easy and as much quality of melt as possible may not be mixed with a heat carrier in the same tub is provided.

[0006]Therefore, a heat exchanger for warming cold water by a hot heat carrier is put on the upper part of a heat storage tank, While placing a heat exchanger which warms a heat carrier which got cold by heat exchange in the lower part of a heat storage tank by heat from an external heat source, placing a longwise container which put in and sealed quality of melt for accumulation in the middle and a heat carrier in a heat storage tank convecting in a sliding direction, it is made to perform heat exchange of a substance for accumulation, and a heat carrier.

[0007]In order to promote a convection of a sliding direction, a septum of a sliding direction made with a heat insulating material is provided between a longwise container group which put in quality of melt, and a wall of a case of a heat storage tank so that an above flow and a down flow may not be mixed. In order for a little heat carriers to perform heat exchange efficiently and to raise thermal energy density of a heat storage tank, a pump for making a flow of a heat carrier prosperous near the heat exchanger which takes in heat is installed.

[0008]

[Embodiment of the Invention]Drawing 1 shows a 1st embodiment of this invention, (a) is drawing of longitudinal section and (b) is a cross-sectional view. As for the container into which 1 put the heat storage tank, 2 put the case, and 3 put the upside heat exchanger and the substance for [4] accumulation in a lower heat exchanger and 5 by drawing 1, the substance for accumulation in 6, and 7, the heat carrier in a heat storage tank and 8 are thermal insulation.

[0009]The case 2 is formed with metal and is having the exterior covered with the thermal insulation 8. The inside is put into the heat carrier 7. This heat carrier 7 is for heat exchange, and does not mainly come out outside from the case 2. When used below 100 **, water is generally used as the heat carrier 7. In a hot case, an oil etc. are used.

[0010]When the upper part of the case 2 is released by the atmosphere, the heat carrier of only the amount of evaporation of the heat carrier for an elevated temperature is sometimes filled up. When sealing the case 2 and preventing evaporation of the heat carrier 7, only the intensity which can bear the steam pressure of the heat carrier in service temperature is given to the case 2, and is placed. It is metal or a plastic, the container 5 was longwise formed with the cylindrical shape, formed hollow sections and has sealed the upper and lower ends so that the substance 6 for accumulation can be put into an inside, so that it may mention later.

[0011]The heat carrier 7 warmed by the lower heat exchanger 4 carries heat to the

upside heat exchanger 3 by convection movement of a flow as shown with the dashed line of drawing 1. In accordance with the flow, the longwise container 5 is formed in the middle of the convection movement. In the container 5, the substance 6 for accumulation is contained. When the heat carrier 7 convects, heat exchange is performed between the internal substance 6 and the heat carrier 7 through the wall of the container 5. When the temperature of the heat carrier 7 is higher than the melting point of the substance 6, the temperature stops at the melting point until the substance 6 reaches the melting point, and begins to melt and the substance 6 all melts. If the substance 6 all melts, the temperature of the substance 6 will begin to go up again, and temperature will go up till the place balanced with the temperature of the heat carrier 7.

[0012]In the case of the calorifier by night power, the heat carrier 7 is warmed through the heat exchanger 4 at night by electric power, and the substance 6 is in the state where carried out the heat carrier 7 and heat exchange, and it all melted. When daytime comes and electric power is off, in order to use chilled water as hot water, it lets chilled water pass to the heat exchanger 3. Chilled water is used as hot water with the heat which can be being stored in the heat carrier 7 which is warmed at night and is in the circumference of the heat exchanger 3 if it does so. If it does so, by the heat exchanger 3, temperature will be lowered, density will go up and convection movement to down will raise the heat carrier 7 which carried out heat exchange. And convection movement of a sliding direction as shown with the dashed line of drawing 1 comes to take place.

[0013]When it passes along the substance 6 side, the heat carrier 7 which is carrying out the above convection at this time carries out heat exchange from the substance 6, and raises that temperature. Instead, the temperature of the substance 6 falls. And if the temperature reaches the melting point of the substance 6, it is begun to solidify the substance 6 which has melted and it will be emitted to the heat carrier 7 by making into the heat of solidification the heat stored as the heat of fusion. The temperature of the heat carrier 7 is mostly maintained at the temperature of the melting point of the substance 6 in the meantime. If the melted substance 6 solidifies all, discharge of the heat of solidification from the substance 6 will be finished, and the temperature of the heat carrier 7 will begin to fall again. The heat stored in the substance 6 between this convection movement is all emitted to the heat carrier 7.

[0014]What is necessary is just to choose the substance 6 which has the melting point between 40 ** thru/or about 100 ** as the substance 6 with a heat storage tank 100 ** or less to obtain about 40 ** hot water. As the heat carrier 7, water is suitable. In the case of industrial use, if it becomes an elevated temperature like [in the case of

exceeding 200 **], and water is used [although what is necessary is just to choose the suitable substance 6 with the temperature to be used,] for the heat carrier 7, since the necessity of the steam pressure amounting to tens of atmospheres, and examining the intensity of the case 2 well will arise, it is good to use a suitable oil etc. instead of water. Water is good, when obtaining a high-pressure steam, of course, turning a steam turbine and carrying out power generation etc.

[0015]Although many what are suitable as the substance 6 can be discovered in various kinds of crystallines and organic compounds, or a plastic, as a suitable thing for a use 100 ** or less, naphthalene with the melting point of nearly 80 ** is mentioned, for example like a calorifier for home use. The melting point of naphthalene shall be 80.5 ** and the heat of fusion is carried out in 33.7 calories/g.

[0016]The effect is verified for the heat characteristic of naphthalene as the aforementioned passage now. Only with the hot water with which the contents of the heat storage tank 1 became an elevated temperature first, the substance 6 for accumulation examines the case where 40 ** hot water is made, as what is not used. In this case, hot water is making the duty of the heat carrier 7 and the substance 6 for accumulation serve a double purpose. If temperature when it presupposes that the temperature of the beginning of the hot water of the heat storage tank 1 is warmed by even 100 ** and heat exchange is finished shall be 40 **, The quantity of heat which can emit the specific heat of hot water about 1 g of 100 ** hot water as 1 calorie/** per 1 g of hot water is 0.5x(100-40) =30 calorie. Instead of 1 g of hot water, the case where 0.5 g of hot water and 0.5 g of naphthalene are used is examined.

[0017]The quantity of heat which the quantity of heat which hot water emits is 0.5x30=15 calorie since quantity becomes half, and naphthalene emits is 0.5x33.7x(80-40) =674 calorie, and the quantity of heat which hot water and the substance 6 emit is 689 calories in total. When the hot water as the heat carrier 7 is reduced by half and a next half is made into naphthalene of the same mass as hot water, it is saying that the accumulation of one about 23 times [in case all are hot water] the quantity of heat of this can be carried out. It is saying that the quantity of heat which can carry out accumulation if it puts in another way and naphthalene which is the heat storage tank 1 of the almost same weight and volume, and is the hot water and the substance 6 of the heat carrier 7 will be used by halves increases about 20 times only in the case of hot water since the density's is 1.16 in the case of naphthalene and it is the almost same density as hot water. Of course, the mass of the heat carrier 7 and the substance 6 does not necessarily need to be half-and-half.

[0018]Although the suitable substance which demonstrates the effect same in addition

to naphthalene is in many crystallines and plastics as mentioned above, if it is a substance which, in short, has the suitable melting point and the large heat of fusion, it can expect a large effect. Although steps softening is carried out [not having the melting point to which it clarified like a crystalline in the case of the plastic] and it becomes liquefied at last, many quantity of heat can be stored from the heat carrier 7 of only mere water like a crystalline also in this case.

[0019]However, an effect is not expectable, if such a substance 6 was only mixed with the heat carrier 7 and being put in the heat storage tank 1. It is because it generally does not mix with the heat carrier 7, such a substance 6 is collected into the upper part or the lower part of the heat storage tank 1 when it melts, and it becomes impossible to expect the heat exchange with the heat carrier 6. Therefore, the substance 6 put into a microcapsule, a corpuscle-like container, etc. was used conventionally.

[0020]In order to make it distributed almost equally in the heat carrier 7 in this invention so that it may not be mixed with the heat carrier 7, even if the substance 6 melts, the longwise container 5 is used by it. It is because a free convection happens easily and heat exchange of the heat carrier 7 and the substance 6 is efficiently performed from the method of the aforementioned former [way / of this method].

[0021]Drawing 2 shows the embodiment of the container 5, in drawing 2, (a) is drawing of longitudinal section and (b) is a cross-sectional view. The container 5 formed the outer wall 51 and the wall 52 in the concentric double pipe by drawing 2, hollow sections were formed between them, and the substance 6 for accumulation which repeats fusion and coagulation is contained in it. The container 5-1 is most located outside in the container group 5. 9 is the heat insulating material attached to the wall of the outside of the container 5-1. The container 5 is made longwise, and it is formed so that a longitudinal direction may meet the flow of a convection, so that a heat carrier may not be prevented from fluctuating by convection movement 7. Therefore, it is provided so that a longitudinal direction may generally become vertical.

[0022]The pipe of the outside which forms the container 5, and an inside pipe, i.e., the interval of the outer wall 51 and the wall 52, are small chosen as about several millimeters or less so that heat may reach the inside of the substance 6 early. And the both ends are sealed so that it may not be mixed with the heat carrier 7. Generally only a piece is not simply used but two or more containers 5-1 with which diameters differ, 5-2, and 5-3 are used as the container 5 is illustrated by drawing 2. Although the wall which forms the container 5 is built with metal or a plastic, the thickness is made thin in order to improve heat conduction. Copper of thin meat, etc. are most suitable.

[0023]However, when performing heat exchange by a free convection, as the wall of the

outside of the container 5-1 is made from drawing 2 with a good material of heat insulation nature or this wall top is covered with the heat insulating material 9, heat insulation nature is improved. This is because the specific gravity of the heat carrier 7 will become light by a rise in heat, therefore a free convection will come to be barred, if heat exchange is considered as the container 5 and it is warmed by the middle, while the heat carrier 7 with which temperature fell is going caudad in accordance with the wall inside the case 2 by the heat exchanger 3. Since it is the same, a method as shown in drawing 3 is also effective.

[0024]Drawing 3 is drawing of longitudinal section showing a 2nd embodiment of this invention, and 11 is a cylinder of the thermal shield pipe made, a good material, for example, the heat-resistant plastic, of heat insulation nature. It is arranged so that both may be separated between the periphery of the container 5-1 of the outermost part of this cylinder 11, and the wall of the case 2. It is a crevice which 12 is in the crevice between the cylinder 11 and the case 2, and has 13 in the circumference of the container 5 inside the cylinder 11. Heat exchangers are omitted and are being fixed to cylinder 11 case. The heat carrier 7 with which temperature fell in the heat exchanger 3 in the case of drawing 3 goes caudad through the crevice 12 between the outside of the cylinder 11, and the case 2, and the heat carrier 7 warmed by the heat exchanger 4 goes up through the crevice 33 inside the cylinder 31. In this way, a free convection is attained favorably.

[0025]When using the cylinder 11, the container 5 is good to make all from a good material of heat conduction, and a thing like the heat insulating material 9 of drawing 2 is unnecessary for it. Although the case 2 is a cylindrical shape and the container 5 is also formed in the cylindrical shape according to it in explanation of a more than with sufficient making area of the crevice 12 between the cylinder 11 and the case 2 almost the same as the gross area of the crevice 13 inside a cylinder, The advantage of this invention of the above [the case of the rectangular cube type instead of a cylindrical shape] is employed efficiently. In this case, the container 5 and the cylinder 11 are made by the rectangular parallelepiped according to it.

[0026]Drawing 4 is a 3rd embodiment of this invention, (a) is drawing of longitudinal section and (b) is a cross-sectional view. In drawing 4, the container 15 has a circular section, or it is formed in the longwise pipe which carried out the ellipse form or the square shape, and two or more they are arranged on the average. As illustrated, longwise, the pipe of the container 5 is usually attached vertically, and it is sealed at both ends like the case of drawing 2 so that the substance 6 may not be mixed with the heat carrier 7, so that the convection of the heat carrier 7 may not be barred. When using a free convection also in this case, it is good to use the cylinder 11 as illustrated.

Heat exchangers are omitted.

[0027]Drawing 5 is the vertical section which shows a 4th embodiment of this invention, and in order to make the convection of the figure heat carrier 7 prosperous, it shows the embodiment which installed the pump. 17 is a pump in drawing 5. The screw pump generally fits this pump 17. Thus, since convection movement of the heat carrier 7 prospers when the pump 11 is installed and the mutual interval of the pipe group which forms the container 5 can be made small, the substance for much accumulation can be accommodated into the same case 2 of capacity. If it puts in another way, the accumulation of more quantity of heat can be carried out with the case of the same capacity.

[0028]When using the pump 17, it is not necessary to necessarily use the container 5 longwise. Since a free convection is not used but controlled circulation is carried out, it may be put to sleep oblong and may use. The pump 17 can be installed also in 1st and 2nd embodiments. It is better to form the cylinder 11, in order to convect favorably although the cylinder 11 is not necessarily needed for [when using the pump 17].

[0029]Next, other uses other than the use referred to as that volume of the heat storage tank for storing the same quantity of heat of this invention is made smaller than the heat storage tank by the conventional hot water are described. As compared with the heat storage tank by the conventional hot water in which the same quantity of heat is stored, volume will be 1/20, considering the case where the heat storage tank 1 using naphthalene of this invention as a thermal storage material is used as a solar heat collector's heat storage tank, and. The quantity of the water as the heat carrier 7 sets quantity of a heat carrier, and quantity of a thermal storage material to 1:1, and is set to 40 about 1/.

[0030]Therefore, since calorific capacity is small, the heat carrier 7 warmed by solar heat can raise temperature earlier [one / 10 times the number of this] than the case of the heat storage tank by the conventional hot water, and can carry heat to the heat exchanger 3 from the heat exchanger 4, until it becomes the melting point of 80 ** of naphthalene. If it puts in another way, since the sun begins to shine, the use that the hot water up to 80 ** can be obtained is in the inside of a short time. Although the time taken to raise temperature exceeding 80 **, of course is the same in the mold which carries out accumulation with the hot water where the former is large-sized, however since there are at least 80 ** or less of sufficiently big uses in the case of a solar heat collector, this use is a serious advantage.

[0031]

[Effect of the Invention]As described above, this invention is an easy structure, can

store a lot of thermal energies at the temperature of the melting point of the substance for accumulation with small capacity, and, Since the early heat storage tank of the response which can shorten the heat response time to the temperature, applies to the energy system using night power or solar heat, and can accumulate many quantity of heat in a small area can be supplied, it is very effective.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]A 1st embodiment of this invention is shown, (a) is drawing of longitudinal section and (b) is a cross-sectional view.

[Drawing 2]Drawing of longitudinal section and (b of an example of the container of this invention and (a)) are cross-sectional views.

[Drawing 3]It is a cross-sectional view showing a 2nd embodiment of this invention.

[Drawing 4]A 3rd embodiment of this invention is shown, (a) is drawing of longitudinal section and (b) is a cross-sectional view.

[Drawing 5]It is drawing of longitudinal section showing a 4th embodiment of this invention.

[Description of Notations]

1 Heat storage tank

2 Case

3 An upside heat exchanger

4 A lower heat exchanger

5 and 15 Container

6 The substance for accumulation

7 Heat carrier

8 Thermal insulation

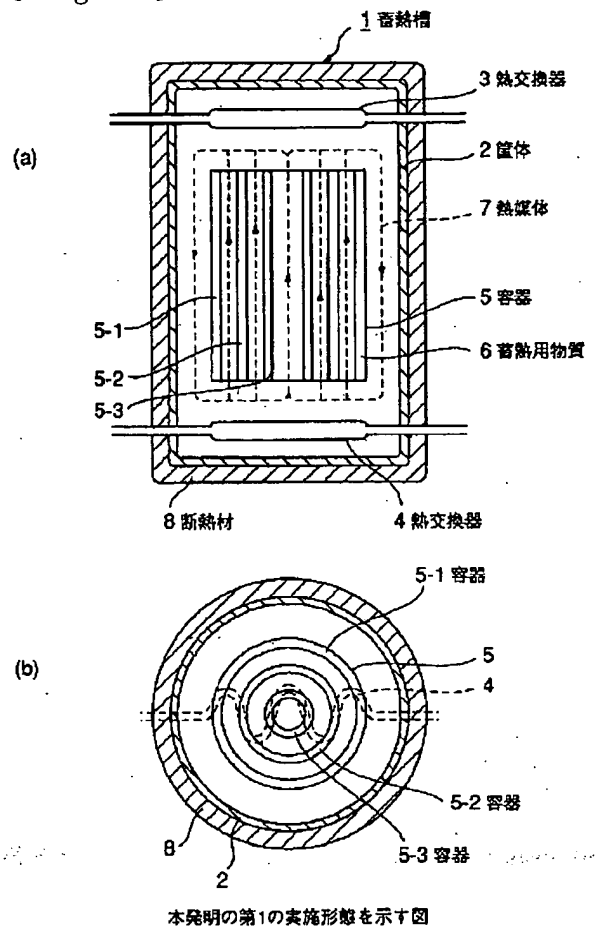
9 Heat insulating material

11 Cylinder

17 Pump

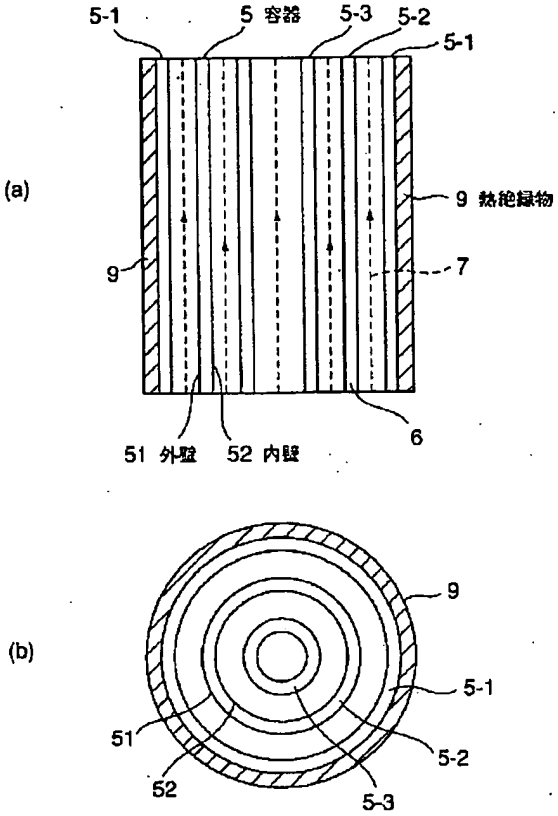
DRAWINGS

[-- figure 1]



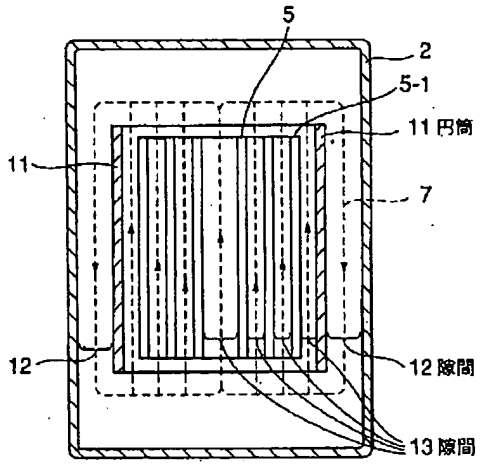
本発明の第1の実施形態を示す図

[· · figure 2]



本発明の容器の実施形態を示す図

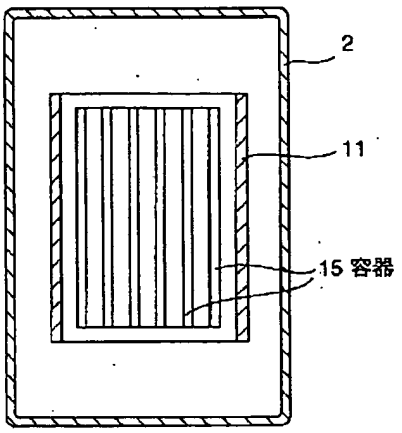
[· · figure 3]



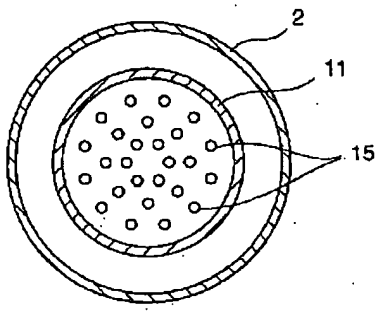
本発明の第2の実施形態を示す縦断面図

[-- figure 4]

(a)

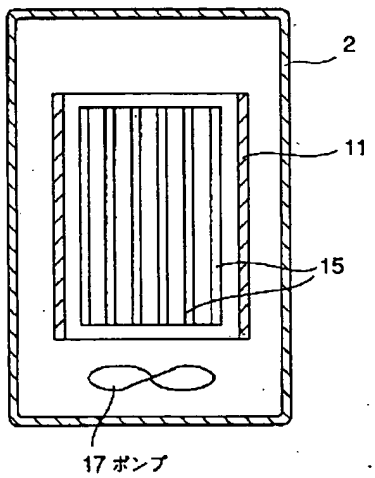


(b)



本発明の第3の実施形態を示す図

[-- figure 5]



本発明の第4の実施形態を示す縦断面図

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

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Ｆ０３Ｇ　6/00	５２１	Ｆ０３Ｇ　6/00	５２１	
Ｆ２８Ｄ　20/02		Ｆ２８Ｄ　20/00	Ｃ	

審査請求　未請求　請求項の数８　書面　（全　６　頁）

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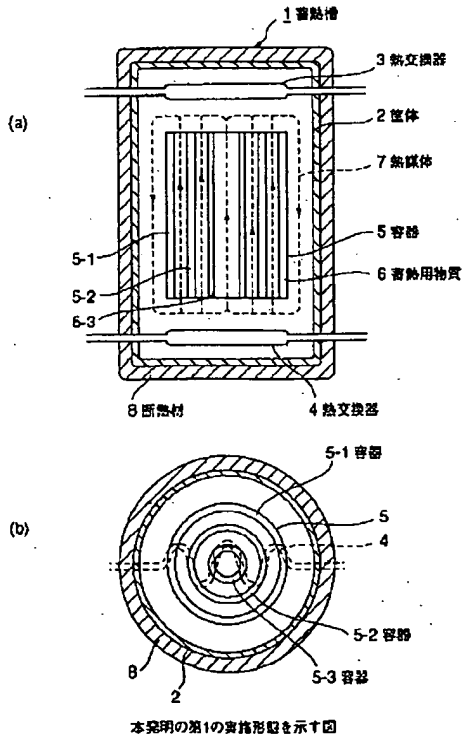
(54)【発明の名称】　蓄熱槽

(57)【要約】
【課題】　簡単な構造で熱エネルギー密度の高い蓄熱槽を得ることを課題とする。
【解決手段】　目的とする温度の範囲内で凝固と融解を繰り返して融解熱の形で多量の熱を蓄えられる物質６をを縦長の密閉容器５にいれて、この容器５を複数熱交換用の熱媒体７内に、熱交換のための熱媒体７の対流運動を妨げない形で入れて蓄熱槽１を形成する。



本発明の第1の実施形態を示す図

1

【特許請求の範囲】

【請求項１】　熱を取り入れる熱交換器と熱を取り出す熱交換器と、熱の移動を行う熱媒体と、物質の融解熱を利用して蓄熱する蓄熱物質と、それらを収容する筐体とを備えた蓄熱槽において、

前記蓄熱用物質を縦長の密閉した容器に入れ、前記容器をその長手方向が熱媒体の対流の方向になるようにして複数個配置したことを特徴とする蓄熱槽。

【請求項２】　前記容器を直径の差の少ない二つの同心の二重のパイプで外壁と内壁を形成すると共にその両端を密閉して構成し、更に直径の異なる前記容器を同心円状に複数個配置したことを特徴とする請求項１記載の蓄熱槽。

【請求項３】　前記複数個の容器のうち、最も外側に位置する円筒の外側を熱絶縁性をもつように構成したことを特徴とする請求項２記載の蓄熱槽。

【請求項４】　前記複数個の容器の外側と、前記筐体の内壁との間に、この両者を隔てるように熱絶縁性をもつ熱遮蔽筒を配置したことを特徴とする請求項１又は２記載の蓄熱槽。

【請求項５】　前記熱遮蔽筒が熱絶縁性の良い材料で形成された円筒であることを特徴とする請求項４記載の蓄熱槽。

【請求項６】　前記容器が両端を密閉したパイプであることを特徴とする請求項１記載の蓄熱槽。

【請求項７】　前記蓄熱用物質がナフタレンであることを特徴とする請求項１～６のいずれかに記載の蓄熱槽。

【請求項８】　前記熱を取り入れる熱交換器の近傍に、前記熱を取り出す熱交換器に向けて、前記熱媒体を移動させるポンプを設けたことを特徴とする請求項１～７のいずれかに記載の蓄熱槽。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、夜間電力利用の温水器や太陽熱温水器のように、供給と需要に時間差のある熱利用システムに利用される、熱エネルギーを蓄える蓄熱槽に関するものである。

【０００２】

【従来の技術】従来は家庭用の夜間電力による電気温水器或いは太陽熱温水器では、比熱の大きい水を利用し高温の水を作って熱エネルギーを蓄えるか、適当な温度で液相－固相間の相変化を起こす物質を小球状容器等に入れて熱媒体を入れた蓄熱槽の内部に充填する方法等が採られていた。前者は蓄熱するエネルギーに対する蓄熱槽の大きさが大きいという欠点があり、後者は、蓄熱槽内の自然対流が順調に行かず、相変化を起こす物質と熱媒体との熱交換の効率が悪かった。

【０００３】

【発明が解決しようとする課題】電気温水器或いは太陽

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熱温水器のようなエネルギーを得る時刻とエネルギーを使う時刻とが必ずしも一致しない給熱ステムで使われる蓄熱槽で、従来の高温の湯を作って蓄熱する蓄熱槽と同じ容積で、更に多くのエネルギーを蓄えられるようにした蓄熱槽を提供することを課題とする。

【０００４】

【課題を解決するための手段】上記した課題を解決するため、本発明は物質の融解熱を利用する。良く知られるように、物質を融解するには多量の融解熱を必要とし、その融解熱はその物質が凝固するときに放出される。この性質を利用し水または油等の熱媒体の入った蓄熱槽内に、適当な温度で融解する物質を入れておき、この物質の融解熱の形で熱エネルギーを蓄えるようにする。

【０００５】そのためにこの物質と熱媒体との間の熱交換を容易にし、且つ同じ槽の中に出来るだけ多くの融解物質を熱媒体と交じり合わないように収納出来るような構造を提供する。

【０００６】その為に、蓄熱槽の上部に熱い熱媒体で冷たい水を暖めるための熱交換器を置き、蓄熱槽の下部に熱交換によって冷めた熱媒体を外部の熱源からの熱で暖める熱交換器を置き、その中間に蓄熱用の融解物質を入れて密閉した縦長の容器を置き、蓄熱槽内の熱媒体が上下方向に対流する間に、蓄熱用の物質と熱媒体との熱交換を行うようにする。

【０００７】上下方向の対流を助長する為に、上方向の流れと下方向の流れが交じり合わないように、融解物質を入れた縦長の容器群と蓄熱槽の筐体の内壁との間に、熱絶縁物で出来た上下方向の隔壁を設ける。少量の熱媒体で熱交換を効率良く行い、蓄熱槽の熱エネルギー密度を上げるために、熱を取り入れる熱交換器の近傍に熱媒体の流れを盛んにするためのポンプを設置する。

【０００８】

【発明の実施の形態】図１は本発明の第１の実施形態を示し、（ａ）は縦断面図、（ｂ）は横断面図である。図１で１は蓄熱槽、２はその筐体、３は上部の熱交換器、４は下部の熱交換器、５は蓄熱用の物質を入れた容器、６は蓄熱用の物質、７は蓄熱槽内の熱媒体、８は断熱材である。

【０００９】筐体２は例えば金属で形成され、断熱材８で外部を覆われている。内部は熱媒体７が入れられている。この熱媒体７は主として熱交換用のものであり筐体２より外部に出ることはない。１００℃以下で使われる場合は、一般的には水が熱媒体７として使われる。更に高温の場合は油等が用いられる。

【００１０】筐体２の上部が大気に解放されている場合は高温のための熱媒体の蒸発量だけの熱媒体を時々補充してやる。筐体２を密閉して熱媒体７の蒸発を防ぐ場合は、使用温度での熱媒体の蒸気圧に耐えられるだけの強度を筐体２に持たせて置く。容器５は後述するように、金属又はプラスチックで、円筒形で縦長に形成され、内

部に蓄熱用の物質６を入れられるように中空部分を形成して上下端を密閉している。

【００１１】下部の熱交換器４で暖められた熱媒体７は、図１の破線で示されたような流れの対流運動によって上部の熱交換器３に熱を運ぶ。その対流運動の途中に流れに沿って縦長の容器５が設けられている。容器５の中には蓄熱用の物質６が入っている。熱媒体７が対流するときに、容器５の壁を通して内部の物質６と熱媒体７との間で熱交換が行われる。熱媒体７の温度が物質６の融点より高い場合は、物質６はその融点に達して融け始め、物質６が全部融けるまでその温度は融点に止まる。物質６が全部融けると、物質６の温度は再び上がり始め、熱媒体７の温度と均衡するところまで温度は上がる。

【００１２】夜間電力による温水器の場合、夜間には電力によって熱交換器４を通して熱媒体７は暖められて、物質６は熱媒体７と熱交換をして全部融けた状態にある。昼間になって電力が切れている時に冷水をお湯にするには、冷水を熱交換器３に通す。そうすると夜間に暖められて熱交換器３の周囲にある熱媒体７に蓄えれている熱によって、冷水をお湯にする。そうすると熱交換器３によって熱交換をした熱媒体７は温度を下げて密度が上がり、下方向への対流運動が起こす。そして図１の破線で示したような上下方向の対流運動が起こるようになる。

【００１３】この時上方向への対流をしている熱媒体７は、物質６の側を通る時に物質６から熱交換をしてその温度を上げる。その代わりに、物質６の温度は下がる。そしてその温度が物質６の融点に達すると、融けている物質６は凝固し始めて、融解熱として蓄えた熱を凝固熱として熱媒体７に放出する。この間熱媒体７の温度はほぼ物質６の融点の温度に保たれる。融けていた物質６が全部凝固すると、物質６からの凝固熱の放出は終わり、熱媒体７の温度は再び下がり始める。この対流運動の間に、物質６に蓄えられた熱は全部熱媒体７に放出される。

【００１４】１００℃以下の蓄熱槽で、４０℃程度のお湯を得たい場合、物質６としては、融点が４０℃乃至１００℃位の間にある物質６を選べば良い。また熱媒体７としては水が適している。工業用の場合は使用する温度によって適当な物質６を選べばよいが、２００℃を越す場合のような高温になると、熱媒体７に水を用いるとその蒸気圧が数十気圧に達して、筐体２の強度について良く検討する必要が生ずるから、水の代わりに適当な油等を用いると良い。勿論高圧の蒸気を得て蒸気タービンを回して、発電等をするようなときは、水が良い。

【００１５】物質６として適当なものは、各種の結晶体や有機化合物やプラスチックのなかに数多く発見できるが、例えば家庭用の温水器のように１００℃以下の用途に適当なものとしては、８０℃近辺の融点をもつナフタレンが挙げられる。ナフタレンの融点は８０．５℃、その融解熱は３３．７カロリー／グラムとされている。

【００１６】いまナフタレンの熱特性を前記の通りとしてその効果を検証してみる。先ず蓄熱槽１の内容が高温になったお湯だけで、蓄熱用の物質６は使われていないものとして、４０℃のお湯を作る場合について検討する。この場合お湯は熱媒体７と蓄熱用の物質６の役目を兼用している。蓄熱槽１のお湯の最初の温度を、１００℃に迄暖められているとし、熱交換を終わったときの温度を４０℃とすると、お湯の比熱をお湯１グラムにつき１カロリー／℃として、１グラムの１００℃のお湯について放出できる熱量は０．５×（１００－４０）＝３０カロリーである。１グラムのお湯の代わりに、０．５グラムのお湯と０．５グラムのナフタレンを用いた場合について検討する。

【００１７】お湯の放出する熱量は量が半分になるから０．５×３０＝１５カロリーで、ナフタレンの放出する熱量は０．５×３３．７×（８０－４０）＝６７４カロリーで、お湯と物質６の放出する熱量は合計６８９カロリーである。熱媒体７としてのお湯を半分に減らし、後の半分をお湯と同じ質量のナフタレンにすると、全部がお湯の場合の約２３倍の熱量を蓄熱できると言うことである。ナフタレンの場合その密度は１．１６で、殆どお湯と同じ密度であるから、換言すれば、殆ど同じ重量と体積の蓄熱槽１で、熱媒体７のお湯と物質６であるナフタレンを半分づつ使うと蓄熱できる熱量は、お湯だけの場合のほぼ２０倍になると言うことである。勿論熱媒体７と物質６の質量は必ずしも半々である必要はない。

【００１８】ナフタレン以外に同じような効果を発揮する適当な物質は、前記のように数多くの結晶体やプラスチックのなかにあるが、要は適当な融点と大きい融解熱を持つ物質ならば大きい効果が期待できる。プラスチックの場合は結晶体のように、はっきりした融点は持たず、段々軟化して終に液状になるが、この場合も結晶体と同じように、単なる水だけの熱媒体７より多くの熱量を蓄えることができる。

【００１９】しかしながら、このような物質６を単に熱媒体７と混合して蓄熱槽１の中に入れたのでは効果は期待できない。何故ならこのような物質６は一般的に言って熱媒体７と混合しないし、融けた場合は蓄熱槽１の上部或いは下部に纏まってしまい、熱媒体６との熱交換は期待出来なくなるからである。その為に従来は例えばマイクロカプセルとか小球状の容器等に入れた物質６が用いられていた。

【００２０】本発明では物質６が、融けても熱媒体７と交じり合わないように、且つ熱媒体７の中にほぼ平等に分布させる為に縦長の容器５を用いる。この方式のほうが、前記の従来の方式より、自然対流が起こり易く、熱媒体７と物質６との熱交換が効率良く行われるからである。

【００２１】図２は容器５の実施形態を示し、　図２で（ａ）は縦断面図、（ｂ）は横断面図である。図２で容器５は同心の二重のパイプで外壁５１と内壁５２を形成し、その間に中空部分を形成し、その中に融解と凝固を繰り返す蓄熱用の物質６が入っている。容器５－１は容器群５の中で一番外側に位置しているものである。９は容器５－１の外側の壁に取り付けられた熱絶縁物である。容器５は熱媒体７が対流運動で上下するのを妨げないように、縦長に作られ、長手方向が対流の流れに沿うように設けられる。従って一般的には長手方向が垂直になるように設けられる。

【００２２】容器５を形成する外側のパイプと内側のパイプ、即ち外壁５１と内壁５２との間隔は、物質６の内部に熱が早く到達するように、小さく例えば数ミリメートル以下位に選ばれる。そして熱媒体７と交じり合わないように、その両端は密閉されている。容器５は図２に図示されているように、一般的にはただ一個だけが使われるのではなく、直径の異なる複数個の容器５－１、５－２、５－３が用いられる。容器５を形成する壁は金属またはプラスチックでつくられるが、熱伝導を良くするためにその厚さは薄くされる。薄肉の銅などが最も適している。

【００２３】但し自然対流で熱交換を行う場合は、図２で容器５－１の外側の壁は、熱絶縁性の良い材料で作るか、或いはこの壁の上を熱絶縁物９で覆うようにして、熱絶縁性を良くしておく。その理由は、熱交換器３によって温度の下がった熱媒体７が筐体２の内側の壁に沿って下方に向かっているときに、その途中で容器５と熱交換をして暖められると、熱媒体７の比重が温度上昇によって軽くなり、そのため自然対流が妨げられるようになるからである。同じ理由から、図３に示したような方法も有効である。

【００２４】図３は本発明の第２の実施形態を示す縦断面図で、１１は熱絶縁性の良い材料例えば耐熱性プラスチックで作られた熱遮蔽筒の円筒である。この円筒１１の最も外側の容器５－１の外周と筐体２の内壁との間に、両者を隔てるように配置される。１２は円筒１１と筐体２との間の隙間、１３は円筒１１の内部の容器５の周囲にある隙間である。なお熱交換器等は省略され、また円筒１１筐体に固定されている。図３の場合は熱交換器３で温度の下がった熱媒体７は円筒１１の外側と筐体２との間の隙間１２を通って下方に向かい、熱交換器４で暖められた熱媒体７は円筒３１の内部の隙間３３を通って上方に向かう。こうして自然対流が順調に達成される。

【００２５】円筒１１を使用する場合は、容器５は総て熱伝導の良い材料で作るのが良く、図２の熱絶縁物９のようなものは不必要である。円筒１１と筐体２との間の隙間１２の面積は、円筒内部の隙間１３の総面積とほぼ同じにしておくのが良い以上の説明では筐体２は円筒形になっており、容器５もそれに従って円筒形に形成されているが、円筒形でなく、長方形の箱形の筐体でも前記の本発明の利点は生かされる。この場合容器５も円筒１１もそれに従って直方体に作られる。

【００２６】図４は本発明の第３の実施形態で、（ａ）は縦断面図、（ｂ）は横断面図である。図４では容器１５は、断面が円形か楕円形か角型をした縦長のパイプで形成されそれらが複数本平均的に配置されている。　熱媒体７の対流を妨げないように、図示したように容器５のパイプは縦長に、即ち通常は垂直に取り付けられ、図２の場合と同じように、物質６が熱媒体７と交じり合わないように両端で密閉されている。この場合も自然対流を利用する場合は、図示しているように円筒１１を使用するのが良い。なお熱交換器等は省略してある。

【００２７】図５は本発明の第４の実施形態を示す縦断面で、図熱媒体７の対流を盛んにするために、ポンプを設置した実施形態を示す。　図５で１７はポンプである。このポンプ１７には、一般的にはスクリューポンプが適している。このようにポンプ１１を設置すると熱媒体７の対流運動が盛んになるので、容器５を形成するパイプ群の相互間隔を小さくできるから、同じ容積の筐体２の中に、多くの蓄熱用の物質を収容することができる。換言すると、同じ容積の筐体でより多くの熱量を蓄熱できる。

【００２８】またポンプ１７を用いる場合は、容器５を必ずしも縦長に用いる必要はない。自然対流を利用するのではなく、強制循環をするのであるから、横長に寝かせて用いても良い。なおポンプ１７は第１及び第２の実施形態においても設置することが可能である。また円筒１１はポンプ１７を使用する場合には必ずしも必要とはしないが、対流を順調に行うには、円筒１１を設けた方が良い。

【００２９】次に本発明の、同じ熱量を蓄えるための蓄熱槽の体積が従来のお湯による蓄熱槽より小さく出来ると言う効用以外の、他の効用について述べる。本発明のナフタレンを蓄熱物質として使った蓄熱槽１を太陽熱コレクターの蓄熱槽として使う場合について考えると、同じ熱量を蓄える従来のお湯による蓄熱槽に比較して、体積が１／２０になると共に、熱媒体７としての水の量は、熱媒体の量と蓄熱物質の量を１：１として、約１／４０になる。

【００３０】従って太陽熱によって暖められた熱媒体７は、ナフタレンの融点８０℃になるまでは、熱容量が小さいために、従来のお湯による蓄熱槽の場合より数１０倍早く温度を上げて熱交換器４から熱交換器３へ熱を運ぶことができる。換言すれば、太陽が照り出してから短時間の内に８０℃までのお湯を得ることができるという効用がある。勿論８０℃を越えて温度を上げるのに要する時間は従来の大型の、お湯によって蓄熱する型を同じであるが、しかし太陽熱コレクターの場合８０℃以下で

も十分大きな用途があるから、この効用は大変な利点である。

【００３１】

【発明の効果】上記したように、本発明は簡単な構造で、小さい容量で多量の熱エネルギーを蓄熱用物質の融点の温度で貯蔵出来るし、またその温度迄の熱応答時間を短縮できて、夜間電力や太陽熱を利用するエネルギーシステムに応用して、小さい面積で多くの熱量を蓄積できる応答の早い蓄熱槽を供給することができるので、大変有効である。

【図面の簡単な説明】

【図１】本発明の第１の実施形態を示し、（ａ）は縦断面図、（ｂ）は横断面図である。

【図２】本発明の容器の示し、（ａ）は縦断面図、（ｂ）は横断面図である。

【図３】本発明の第２の実施形態を示す横断面図である。

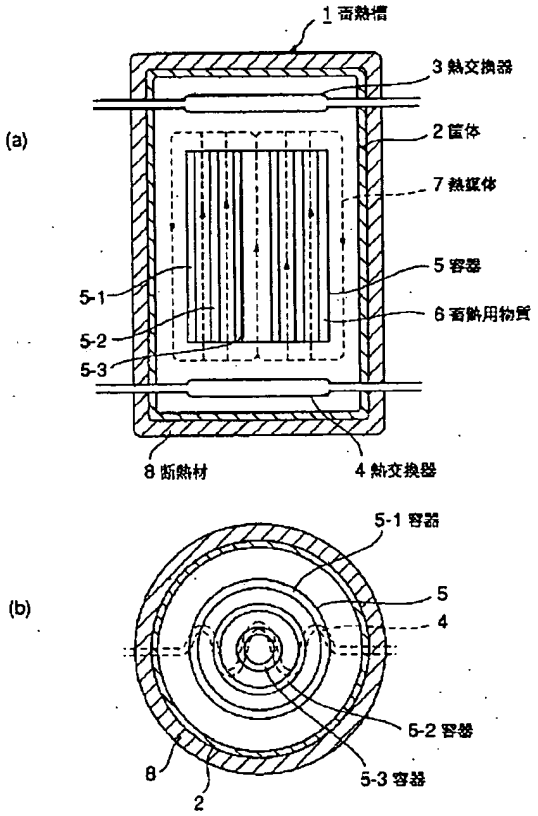
【図４】本発明の第３の実施形態を示し、（ａ）は縦断面図、（ｂ）は横断面図である。

【図５】本発明の第４実施形態を示す縦断面図である。

【符号の説明】

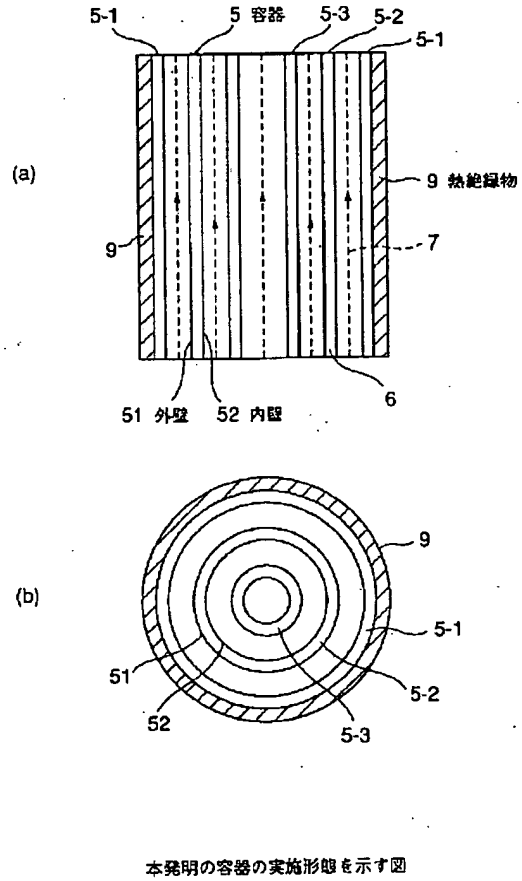
1	蓄熱槽
2	筐体
3	上部の熱交換器
4	下部の熱交換器
5、１５	容器
6	蓄熱用の物質
7	熱媒体
8	断熱材
9	熱絶縁物
１１	円筒
１７	ポンプ

【図　1】



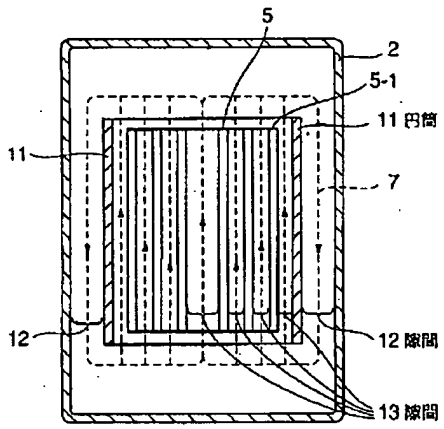
本発明の第1の実施形態を示す図

【図　2】



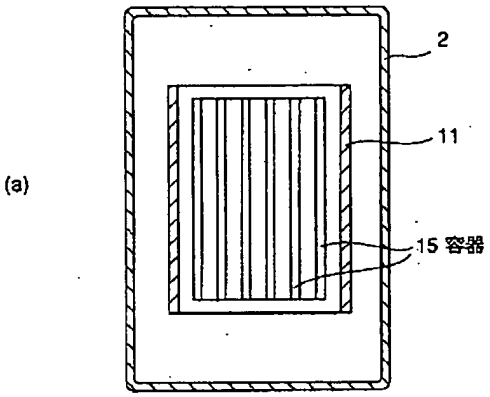
本発明の容器の実施形態を示す図

【図　3】



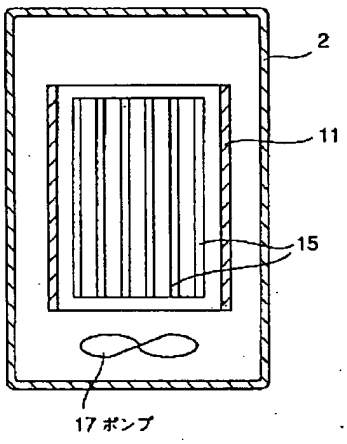
本発明の第2の実施形態を示す縦断面図

【図　4】



本発明の第3の実施形態を示す図

【図　5】



本発明の第4の実施形態を示す縦断面図